



**JOHN DEERE**

***NREL ZCI-3-32027-04***

***Natural Gas Engine Development***

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***“Nothing Runs Like a Deere”***

# Development Requirements

- NREL/ Deere Contract Signed in July 2003
- Development Requirements
  - Engine ratings of 250hp and 735ft-lbs or higher
  - Federal emissions certification to 2004 EPA with appropriate PM standards
    - 0.1g/bhp-hr for truck applications
    - 0.5g/bhp-hr for bus applications
- Task Specifics
  - Task 3.1 Completion of Laboratory Engine Development
  - Task 3.2 On-road Prototype Engine Development in Vehicles
  - Task 3.3 Perform FTP Testing/ Commercialize Engine

# Development Activities

- Task 3.1 Certification to 1.5 and 1.8 g/bhp-hr ( NOx+ NMHC) was funded by Deere prior to signing contract
  - Tasks 3.2, 3.3 Activity initiated after resolution of production control system concern. Software finalized in April 2004, allowed remaining tasks to begin.
- Task 3.2- Field test of engine in WMATA fleet in Washington DC
  - Field test from April-October 2004
  - Excellent performance
  - University of W. Virginia dyno results showed best fuel economy, and lowest emissions of any of the engines tested
- Task 3.3- Perform FTP Testing Commercialization
  - Deterioration Factor testing to achieve lower DF factors with improved control system and power cylinder
  - Test included 1125 hours of durability testing
  - Emissions testing at 125,375,750,1125 hrs
  - DF factors were calculated for useful life of 290K miles MHD
  - DF factors were calculated for useful life of 435K miles HHD and Urban Bus



## Development Activity continued Task 3.3

- Completed DF testing in February 2005
  - Improved factors allowed both 250 and 280 hp versions to meet 1.5gNO<sub>x</sub> +NMHC certification
- Modified subcontract w/NREL to further improve performance and lower emissions using the unspent dollars allocated from Task 3.1.
- Achieved 1.2gNO<sub>x</sub>+NMHC certification for both 250 and 280HP versions.
- Repeated 3 month field test verification of new ratings.
  - (April – June 2005)
- No impact to market leading fuel economy.

# Vehicle Platforms

- Transit Bus Applications:

  - New Flyer C40LF Bus Model (280 hp engine rating)

  - Orion V and VII (both 280 hp engine rating)

  - El Dorado EZ Rider (250 hp engine rating)

  - El Dorado Axess (280 hp engine rating)

- Truck Applications

  - CCC LCF Trash Truck (275/280 hp engine rating)

  - CCC LEW2 Trash Truck (275/280 hp engine rating)

- School Bus Applications

  - Bluebird Rear Engine (250 hp rating)

  - Thomas Rear Engine (250 hp rating)

# Commercialization Efforts

- 1.2gNOx+NMHC certification
- Applied for certifications with EPA & CARB in August 2005
- Production release in September 2005
- Final report TBD for this fall
- Total of 14 certifications in CNG AND LNG
- MHD service class:
  - 250 hp, 800 lb-ft peak torque
  - 250 hp, 735 lb-ft peak torque
- HHD service class:
  - 280 hp, 900 lb-ft peak torque
  - 275 hp, 800 lb-ft peak torque
- UB service class:
  - 280 hp, 900 lb-ft peak torque
  - 275 hp, 800 lb-ft peak torque
  - 250 hp, 735 lb-ft peak torque



# Future Deere Activities: Phase1

- 8.1 2007 dilute burn demonstration engine (May 2004-June 2005)
- Engine development w/ partners Electronic Microsystems (Dan Podner & John Kubash)
- Prototype Engine was equipped with:
  - EMS/Deere prototyping controller
  - EMS/Deere EGR metering system
  - three-way catalyst
- U.S. EPA FTP transient tests were conducted @ SwRI
  - Current 2004 -type particulate sampling system with 90 mm filters
- U.S. EPA FTP Cycle Emissions Test Results
  - Targets (0.2gNO<sub>x</sub>, 0.14gNMHC, 0.01gPM)
  - Engine performed well over cycle
  - Met cycle tracking statistics on first prep cycle
  - Comfortably met sub level targets
- John Deere confident in chosen technology path to meet 2007 (2010) on-highway emissions standards

# Future Deere Activities: Phase 2

## 9.0L Production Engine Development Program

- Current partners EMS, SwRI. SCAQMD contract being finalized
- Optimistic RFP proposal submitted to NREL July 2005 is accepted
- Further development and optimization of chosen technology path from Phase 1 8.1L demo engine
- 1<sup>st</sup> iteration design completed
- Multiple prototypes running
- Proposed development schedule
  - Durability testing scheduled for late 2005 and 2006
  - Field testing in March 2006
  - Pilot production in October 2006
- Additional product information to be released at APTA Conference in September 2005